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New insights on small-scale vortical motion dynamics

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Ubiquitous small-scale vortical motions that are generated on the solar surface at intergranular lanes by the turbulent dynamics of solar convection, are observed in the quiet-Sun atmosphere with dynamic timescales of a few minutes. Most of these convectively driven vortex motions harbour magnetic fields whose forced photospheric rotation often leads to the formation of magnetic tornadoes that penetrate several layers of the solar atmosphere and can reach heights up to the low corona. Both the formation of such magnetic structures and their uninhibited rotation strongly depends on the co-local magnetic field environment and topology, while the resulting twisting, braiding and dynamics of the magnetic field lines within them can drive and foster a wide variety of oscillations and wave modes. These modes include different Alfvenic type waves, such as kink, sausage, and torsional Alfven waves that could significantly contribute to the solar atmospheric heating at different heights. An analysis of recent high-temporal, high-resolution observations in the $H\alpha$ and Ca II IR lines, acquired with the Swedish Solar Telescope (SST), reveals more abundant small-scale vortical motions in the lower atmosphere than previously reported. We explore the role of the magnetic field in the formation of such vortical motions with the use of state-of-the-art magnetoconvection simulations. Moreover, exploiting both simulations and observations, we investigate the role of vortical structures in the small-scale dynamics of the quiet Sun, discuss the presence of Alfvenic type waves within them and provide estimates of the related energy transfer towards higher solar atmospheric layers.

Primary author: Dr TZIOTZIOU, Kostas (IAASARS, National Observatory of Athens, Greece)

Co-authors: Dr KHOMENKO, Elena (Instituto de Astrofisica de Canarias); Dr TSIROPOULA, Georgia (National Observatory of Athens); Mr DAKANALIS, Ioannis (National Observatory of Athens); Dr KONTOGIANNIS, Ioannis (Leibniz-Institute for Astrophysics Potsdam (AIP))

Presenter: Dr TZIOTZIOU, Kostas (IAASARS, National Observatory of Athens, Greece)

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